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LLNL Internship Reflection

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Okay, I never thought I'd be saying this but here it goes: I lov- No, no. I am very fond of the city of Buffalo... as a friend, nothing more. Phew, that was tough. In all honesty though, this internship out in California has taught me that one important lesson. Towards the end of high school, and especially when I was looking at colleges, I could not wait to go anywhere but Buffalo. Of course, as luck (or fate, whichever demon you prefer) would have it, I wound up going to school in Buffalo, too. I ended up growing to enjoy UB; I met some incredible friends and formed the opinion that going to college anywhere is going to be a fun experience. I suppose I am biased but I'll say it anyway, I think the friends I met at UB are the best I could have. They are people that I can very easily relate to because we have such similar backgrounds.

I don't think I had many expectations going into my internship here in California, so it caught me off-guard when I discovered that I don't particularly like it here. I suppose inland, drought-stricken California is probably the more accurate area of concern. It didn't even occur to me when I was packing that California is going through a drought; I still packed my rain jacket. As I was unpacking my things I remember my first roommate, Steve, mentioning the drought as I hung my rain jacket. That's when it first occurred to me that I may not be seeing much rain; in fact, I may not see a decent rainfall at all while I'm in California. For the first month or so I was in constant disbelief that anywhere on Earth, except for maybe the desert, could be this sunny all the time. Eventually I grew used to the constant glare from the sun and grew to love whenever we had a cloudy, overcast morning. (The clouds would be gone within a couple hours, of course; don't be silly.) One day it was actually cloudy the entire day! My friend, Helen, and I celebrated; she's from central New York. Another day, we actually saw a couple rain drops! Rain was definitely one thing I was not expecting to miss.

I'm not sure if it was the lack of self-preparation or the amount of change I went through, but I would be able to survive without living in (inland) California again. I've never been one for sudden change, anyway. I suppose I don't like the discomfort that something new and big sometimes brings. I knew that this would be uncomfortable at first and that it was a necessary step I had to take; I couldn't just turn down a national lab! If the job/ internship market brings me back to the west coast, I would be fine with that; I realize that is a strong possibility with all of the nuclear energy research and development out this way. I simply know now that I would prefer to live closer to the coast where there is more variable weather. I definitely hope that I can ultimately end up at least in the eastern half of the country; my family is very valuable to me and I would hate for money to separate me from them. Sadly, I saw it happen with one of my cousins. So yes, one very big realization I had was that I would definitely like to stay reasonably close to home in the future, once I'm settling down after school and everything. If I have to take more internship opportunities on the west coast ("have to" meaning it would be the smart choice) it wouldn't be terrible; it would be much more of a benefit than a burden.

Speaking of internships on the west coast, I am just about to complete one of those. This was my very first internship of any sort; being from the east coast, I can't believe I made it all the way out here to a *national lab* on my first try! My time here at LLNL has definitely been a unique and unforgettable experience. The project I was assigned to involves radiation detection in two different ways. The first is a hybrid project utilizing three different gamma ray detectors with the ultimate goal of creating a model to be able to combine the information from each detector. Each detector has different strengths, so we hope that combining all three detectors will improve our ability to view situations involving radioactive materials. The other part of the project involves multiple small gamma ray detectors that are highly portable. The goal here is to

create a model and distribute these detectors within the country so that a continuous monitoring system is available.

The three detectors I used to take measurements for the hybrid project were a sodium iodide scintillator, lanthanum bromide RadSeeker, and high purity germanium MicroDetective. Each detector has a resolution of seven, three, and half a percent, respectively. The resolution of a gamma ray detector relates to its ability to distinguish peaks in energy spectra. The lower the percentage, the better the detector's resolving power. There are three main tradeoff factors that influenced the choice of detectors: efficiency, resolving power, and cost. A large detector such as the sodium iodide scintillator has a higher efficiency relative to the other two detectors in the project; the percentage of detected radiation relative to the total possible radiation is good. While cheaper than the other materials, sodium iodide has a relatively poor resolving power. High purity germanium, on the other hand, has poor efficiency but very high resolving power. This material is much more expensive than the other two in question, so if it was not necessary for a good detection system I'm sure it would be left out of the equation when possible. Lanthanum bromide generally falls in the middle for both efficiency and resolving power relative to sodium iodide and high purity germanium. It is also a pretty pricey material because it is not able to be produced in large volumes. With the hybrid model we hope to be able to see improved performance using a combination of detectors rather than a single detector, and as always, cost reduction is ideal.

The small, portable detectors I used to take measurements for the distribution project were Polimaster Personal Radiation Detectors (PRDs). They use cesium iodide for their gamma detector material. These detectors resemble pagers in both their size and appearance making them perfect for personnel such as firemen or policemen to have on them at all times. The

challenge with the “pager detectors,” as we call them, is that they have both very low efficiency and very low resolving power. With the distribution model we hope to be able to combine data from multiple pager detectors near an unknown source to gain more significant gamma ray data to analyze the situation.

My main contribution to these projects was taking measurements that will be used to validate the models that combine gamma ray detector data. The data I’ve taken shows accurate depictions of what particular radioactive isotopes look like to each of the gamma ray detectors. Each measurement can be combined with other measurements to create a good representation of what a specific situation would actually look like to a certain detector, multiple sources and/or weak sources and high versus low resolution detectors, for example. This representation can then be compared to the model simulation of the same situation to see how the model performed. It’s no good if you have a model that creates inaccurate results.

I took the most data (and felt the most like a real-life experimentalist) with the hybrid project. My setup consisted of the three detectors surrounding a center point where the radiation source was placed so that measurements could be taken simultaneously with each of the detectors (Figure 1). To minimize detector inaccuracies, I varied the source-to-detector distance so that each gamma ray detector saw around 2000 counts per second (cps) when possible. I did not place the source within fifteen centimeters of any of the detectors because if the source is too close the radiation will not be properly detected. What can happen is two incident radiation photons interact with the detector at the same time. When this happens, a single output is created that is the combined energy of both photons; obviously an erroneous piece of information. In the beginning the data collection for this project was pretty slow going. It took a few weeks for our group to collect all of the gamma detectors we wanted to use. Fortunately, I was able to have a

lot of freedom in the data collection and got to set up the experiment myself, with guidance from the experts, of course. When I took measurements in the lab I used the same process each time. At the start and end of every set of measurements I took what is called a background measurement. This lasts 30 minutes and is used to detect any variations in the room's "natural" radiation. If there are fluctuations in the background radiation, when we compare the background spectrum to an actual measured spectrum, the background fluctuations will not be mistaken for a radiation source. I then measured a set of nine sources in one minute increments, taking a calibration measurement of a known source every five minutes, and measuring each source for a total of ten minutes. The calibration source is used as a comparison to make sure the detectors aren't shifting the output energies of the incident radiation.

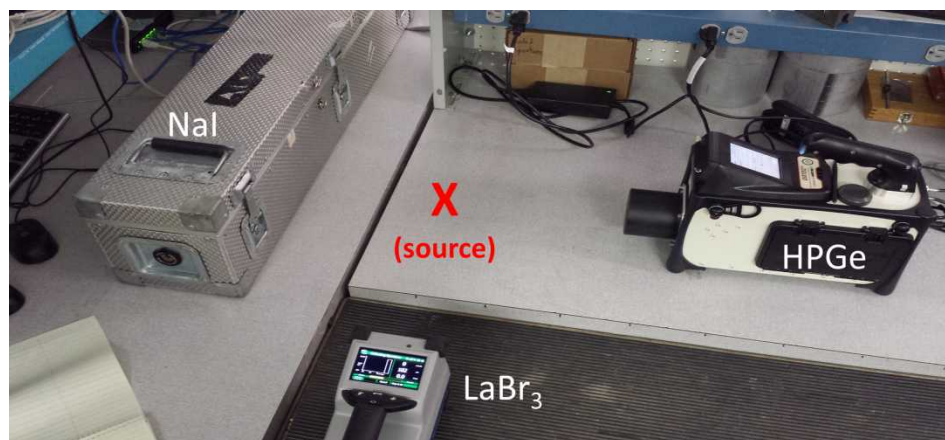


Figure 1

For the distribution project, I spent a lot of my time characterizing the behavior of the apps on the phones to ensure data is not getting lost, as this has been a problem in the past. One of the apps wasn't able to handle more than one detector operating at the same time, and would report back only half of the data from each. From my experience with this particular app, I think the loss of data was fixed. Some questions we have about the pager detectors are if the integration time affects the amount of dead time, or when the detector is unable to measure

anything due to recovery time. There is only so much material in the detector crystal that can sense the incident radiation, so if all of the detector material is being “used” the detector experiences dead time because it literally cannot detect any more radiation for the moment. I made a good number of test measurements with the pagers to calibrate the data. Everything in the spectra needs to be shifted and stretched so that the plotting program displays data at the correct energies. I did this using a number of test sources with known peak energies and a calibration feature in a plotting program that lets you assign an energy value to a peak. From the assigned energies, the program adjusts the calibration of the entire spectrum.

One field test I did with the pager detectors was to take a walk around the lab and pass near a supposed cesium source in a hazardous waste building. From the spectrum that contains the 60 minutes of data (the entire walk), no peaks are evident; it looks like background radiation. However, when I plotted only the data from when I was near the source, it was evident that it was most likely not a cesium 137 source. The characteristic peak for cesium 137 was nowhere to be seen. This prompted me to go back to the building and take a one minute measurement with the RadSeeker that has much better resolution and efficiency. The RadSeeker spectrum had a distinct signature look of an americium 241 spectrum, not cesium 137. This is not an absolute finding, but an educated decision. It was really cool to do some real-life detective work on unknown material and just goes to show the possible application power of these little pager detectors.

My time at LLNL has definitely been invaluable. I have been exposed to cutting-edge technology and research and perhaps some of the brightest minds in the scientific community. DHS as well at the Lab hosted many seminars that were extremely informative and fascinating. Here is a (mostly) comprehensive list of the few (actually, several) I was fortunate to attend:

June

Nuclear Detection
DHS Overview at LLNL
Bio-Security (DHS)
Targets for NIF
WFIRST-AFTA and Euclid Space Dark
Energy Missions
Reach-Back (DHS)
D₃He Gas-Filled Implosion Research at
OMEGA and NIF
Electron Acceleration and X-ray Generation
Using Short Pulse Lasers (NIF)
SLAC Tour
Resonance Ionization Mass Spectrometry
Beta-Delayed Neutron Spectroscopy with
Trapped Fission Products
NIF Specialty Fiber Optics
Nuclear Fusion
NIF Tour

July

Terascale Simulation Facility Tour
Carbon Cycle (DHS)
NIF Large Optics
Student Poster Symposium Workshop
Radiation Detection (DHS)
Breath Analysis (DHS)
A Survey of Possible Ablator Materials for
NIF Ignition Designs
Technology Demonstration of a Highly
Portable Compact DT Neutron Source
High Explosives Applications Facility Tour
Alpha Heating in ICF Implosions on NIF
Learn About the UC Berkeley Experience
Nuclear Detonation (DHS)
Astrophysics on NIF

August

Global Climate (DHS)
Homemade Explosives (DHS)
Ultra-Intense Lasers (NIF)
Student Poster Symposium

I liked the DHS seminars because they exposed me to many research areas that I was not familiar with and probably wouldn't have known about otherwise. However, I have to say I am still a nuclear energy fanatic at heart. The NIF presentations and the seminar specifically about nuclear fusion in general were some of my favorites by far. I often felt very privileged to be introduced to such new research experiments and ideas. This experience has definitely reinforced my desire to work in the nuclear energy industry and lit a stronger fire under my bum to urge me to do some personal research to learn all that I can about nuclear energy. It has opened my eyes to the vast scope of research just within nuclear energy itself, let alone everything else the lab has going on!

My research project itself has taught me so much about radiation detection. Even though it isn't nuclear energy, I have found that I enjoy this subject more than I had expected. I think part of the reason I've liked it is the "danger" factor; radiation isn't something to mess around with, it can be very harmful. So I believe in my mind I associate the dangers of nuclear energy and radiation and subconsciously group them to be fairly similar. I do like that radiation detection does relate to nuclear energy from a fundamental level. In any power plant, you're probably going to have dosimeters much like the ones that are required here at the Lab to monitor employees' radiation doses. I think this internship was definitely a great first step in the right direction for my career path. I met so many interesting scientists and interns. I've also met nuclear engineering students both in undergraduate and in graduate school that have given me some good insight into the schooling and how to go about searching for the right grad school. I think this internship has probably impacted my education far beyond what I realize, and for that I am very grateful.

I think the control of radioactive materials will continue to be a challenge years into the future because of the continued development and research in nuclear energy. Fusion research is definitely a better option than fission in terms of the amount of radioactive material involved, but tritium is still a favorable fuel source for fusion despite its radioactive properties. I think the energy industry would benefit from research into the safety involved in working with tritium. If we could safely produce and manage tritium for fuel, it would be an excellent candidate for use in fusion reactors. Compared to deuterium, tritium reactions produce much more energy. Fossil fuels will not be available forever, and the sooner we stop using them the better, anyway. There are statistics that suggest petroleum and coal reserves will be depleted within the next century and carbon levels in the atmosphere are approaching an all-time high. The drive toward

alternative energy sources will only grow as nonrenewable fuel sources continue to run out.

Nuclear energy will be able to provide large quantities of energy in exchange for much smaller amounts of fuel.